PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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ADAMSON JONES PCT

To:

JONES, Stephen Anthony
AdamsonJones
Broadway Business Centre
32a Stoney Street
Nottingham NG1 1LL
GRANDE BRETAGNE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	21.11.2001
Applicant's or agent's file reference 180/58/P/WO	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/03538	14/09/2000	14/09/1999

Applicant
INTERSURGICAL LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Ipinazar, P Tel.+49 89 2399-8131

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
180/58/P/WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/03538	14/09/2000	14/09/1999
Applicant		
INTERSURGICAL LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established by this Authority to read as follows:

   FILTRATION MEDIA AND THE MANUFACTURE THEREOF

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
180/58/P/WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/03538	14/09/2000	14/09/1999
International Patent Classification (IPC) or national classification and IPC B01D39/02		
Applicant INTERSURGICAL LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11/04/2001	21.11.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Hoffmann, A Telephone No. +49 89 2399 8610

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03538

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-6	as originally filed			
7,8	as received on	03/10/2001	with letter of	03/10/2001

Claims, No.:

1-28	as received on	03/10/2001	with letter of	03/10/2001

Drawings, sheets:

1/1	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	6-14,18-28
	No:	Claims	1-5,15-17
Inventive step (IS)	Yes:	Claims	
	No:	Claims	6-14,18-28
Industrial applicability (IA)	Yes:	Claims	1-28
	No:	Claims	

2. Citations and explanations
   see separate sheet

The following documents are cited in the Int. Search Report:

D1: US-A-5 230 800 (NELSON DAVID L) 27 July 1993 (1993-07-27)
D2: US-A-4 097 965 (GOTCHEL JOEL PETER ET AL) 4 July 1978 (1978-07-04)
D3: US-A-5 778 494 (SOWELL LYLES HOWARD ET AL) 14 July 1998 (1998-07-14)
D4: WO 97 22743 A (DU PONT) 26 June 1997 (1997-06-26)
D5: US-A-5 454 946 (HEAGLE DAVID G ET AL) 3 October 1995 (1995-10-03)
D6: US-A-4 374 894 (ANTLFINGER GEORGE J) 22 February 1983 (1983-02-22)
D7: EP-A-0 406 485 (NPBI BV) 9 January 1991 (1991-01-09)
D8: US-A-3 568 846 (HAEFNER ALBERT J) 9 March 1971 (1971-03-09)
D9: US-A-5 595 659 (LYNCH KEVIN G ET AL) 21 January 1997 (1997-01-21)

POINT V:

1. The subject matter of independent claim 1 seems at first glance to be distinguished from the prior art by the feature "electrostatically-charged". The present application does not give any advices how to charge the fibres electrostatically by respective independent process steps. Studying the present description with regard to this feature the reader learns only that "Electrostatic charging of the fibres is believed to be achieved as the fibres are separated between a set of feed rollers and a single roller, or as they are contacted by the rotors and mesh yarns of the grid". If the electrostatic charge is a consequence of the two described examples of air laid processes of the present application, also the fibres of the prior art air laid processes, for instance D2-D4 (see relevant passages in the Search Report) are charged during the air-laying process. Thus there is in fact no difference between the cited prior art air-laying process and the air-laying process according to claim 1 of the present application. Thus the subject matter of independent claim 1 is not new with regard to the cited prior art.

2. The subject matter of claims 2-5 is not new with regard to D2, abstract (Article 33 (2) PCT). D2 in combination with D7 or D8 (see relevant passages in the Int.

Search Report) does not justify the involvement of an inventive step (Article 33 (3) PCT) of the subject matter of claims 6,7,17,18 or 15-17 respectively. The same is valid for D3 or D4 (see relevant passages in the Int. Search Report) in combination with D6 **or** D7 (See Search Report "Category " and "relevant to claim" in combination with the cited Y-documents).

The remaining dependent claims of claim 1 do not seem to justify the involvement of an inventive step with regard to the respective problem to be solved.

3. Claims 15 and 16 (which are not at all linked with the subject matter of claims 1-14) contain only "desideratum"-features. Thus they cannot justify an involvement of an inventive step (Article 33 (3) PCT).

Since claims 15 and 16 are not linked to the process of claims 1-14, the subject matter of claims 15 and 16 is even not new with regard to D6 (see relevant passages in the Search Report). With regard to claim 2 of D6 (mixture) the subject matter of present claim 17 is not new (Article 33(2) PCT).

The dependent claims 18-28 specify the fibres. Since the description is silent about the effect of the fibres (not the process for the manufacture of a filtration medium!) on the desired uniform strength in all directions, the choice of the fibres cannot justify the involvement of an inventive step (Article 33 (3) PCT).

(i) Up to a 20% reduction in the weight of the fabric can be achieved whilst maintaining a bacterial filtration efficiency of at least 99.9997%.

(ii) Up to a 39% reduction in the resistance to flow can be achieved (compared to the existing art) whilst maintaining a bacterial filtration efficiency of at least 99.9997%.

(iii) Bacterial filtration efficiencies of at least 99.99997% can be achieved with a single layer air-laid structure. No laminated or incorporated layers (eg meltblown fabrics) are required.

Typical results (resistance to flow and filtration efficiency) for fabrics produced using the method of the invention (specifically, the roller-based air-laying approach) are given in Table 1. These samples were a 50:50 blend of polyvinylchloride and polypropylene.

Table 1

Typical Test Results for Air-Laid Media

Sample ref	Fabric weight (g/m^2)	Resistance to flow @60 l/min (cmH_2O)	Bacterial Filtration Efficiency (%)
2E	402	1.4	99.9997
6C	433	1.8	99.9994
4E	463	1.6	99.9998
6B	491	2.1	99.999
4B	529	1.8	99.999
7A	597	2.1	>99.999991

All tests were carried out on a pad of the respective fabric measuring 7.5x5.3cm and welded into a plastic housing with 22mm cylindrical inlet and outlet. Resistance to flow was measured in accordance with BS EN ISO 9360-1:2000. For bacterial efficiency, no standard currently exists. However, all products were tested in accordance with the former draft standard prEN 13328-1 Part 1.

Claims

1. A process for the manufacture of a filtration medium, which process comprises

a) transferring uncharged fibres to an air-laying apparatus;

b) air-laying the fibres onto a support so as to form an electrostatically-charged non-woven web in the form of a single layer; and

c) drawing the web from the support.

2. A process as claimed in Claim 1, wherein the air-laying apparatus comprises a rapidly rotating cylinder or roller clothed with teeth.

3. A process as claimed in Claim 2, wherein the rapidly rotating cylinder or roller clothed with teeth interacts with other toothed rollers or fixed carding plates.

4. A process as claimed in Claim 1, wherein the air-laying apparatus comprises a sifting screen or rotor device in which fibres are circulated over a mesh screen.

5. A process as claimed in any one of Claims 2 to 4, wherein during air-laying the fibres are dispersed in a moving air stream to form an air/fibre mixture.

6. A process as claimed in any preceding claim, wherein the fibres comprise a blend of fibres of two or more types of fibre.

7. A process as claimed in Claim 6, wherein the blend comprises comprises (a) a polyolefin and (b) an addition polymer comprising one or more halogen-substituted hydrocarbons.

8. A process as claimed in Claim 7, wherein component (a) is polypropylene and component (b) is polyvinylchloride and/or polyvinylidene chloride.

9. A process as claimed in Claim 7 or Claim 8, wherein the blend further comprises a modacrylic copolymer comprising from 35 to 85 weight percent acrylonitrile units and having the balance made up substantially of other addition polymer-forming units, being halogenated hydrocarbon such as vinyl chloride or vinylidene chloride.

10. A process as claimed in any one of Claims 7 to 9, wherein the weight ratio of component (a) to component (b) is in the range 70:30 to 30:70.

11. A process as claimed in Claim 10, wherein the weight ratio of component (a) to component (b) is in the range 45:55 to 55:45.

12. A process as claimed in any one of Claims 7 to 11, wherein the linear density of the fibres in component (a) and component (b) is in the range 0.1 to 10dtex.

13. A process as claimed in Claim 12, wherein the linear density of the fibres is less than 3.3 dtex.

14. A process as claimed in any preceding claim, wherein the fibres hav a diameter of 12µm or less.

15. A filtration medium consisting of a single layer of a non-woven web of fibrous material, said web having a ratio of the tensile strengths of the web in the machine and cross directions (MD:CD), ie the longitudinal and transverse directions of the web, of less than 2:1.

16. A filtration medium as claimed in Claim 15, wherein the MD:CD ratio is less than 1.5:1.

17. A filtration medium as claimed in Claim 15 or Claim 16, wherein the web comprises a bl nd of fibres of two or more types of fibre.

18. A filtration medium as claimed in Claim 17, wherein the blend comprises (a) a polyolefin and (b) an addition polymer comprising one or more halogen-substituted hydrocarbons.

19. A filtration medium as claimed in Claim 18, wherein component (a) is polypropylene and component (b) is polyvinylchloride and/or polyvinylidene chloride.

20. A filtration medium as claimed in Claim 18 or Claim 19, wherein the blend further comprises a modacrylic copolymer comprising from 35 to 85 weight p rcent acrylonitrile units and having the balance made up substantially of other addition polymer-forming units, being halogenated hydrocarbon such as vinyl chloride or vinylidene chloride.

21. A filtration medium as claimed in any one of Claims 18 to 20, wherein the weight ratio of component (a) to component (b) is in the range 70:30 to 30:70.

22. A filtration medium as claimed in Claim 21, wherein the weight ratio of component (a) to component (b) is in the range 45:55 to 55:45.

23. A filtration medium as claimed in any one of Claims 18 to 22, wherein the linear density of the fibres in component (a) and component (b) is in the range 0.1 to 10dtex.

24. A filtration medium as claimed in Claim 23, wherein the linear density of the fibres is less than 3.3 dtex.

25. A filtration medium as claimed in any one of Claims 15 to 24, wherein the fibres have a diameter of 12µm or less.

26. A filtration medium as claimed in any one of Claims 15 to 25, which has a weight of from 200g/m² to 1000g/m².

27. A filtration medium as claimed in Claim 26, wherein the medium has a weight of 350-500g/m².

28. A filtration medium as claimed in any one of Claims 15 to 27 which comprises a blend of fibres selected from the group consisting of

a) Polyvinylchloride / Polypropylene;

b) Polyvinylchloride / Modacrylic / Polypropylene;

c) Polyvinylchloride / Polypropylene / Polyethylene; and

d) Polyvinylchloride / Modacrylic / Polyethylene.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
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(71) Applicants *(for all designated States except US)*: **INTER-SURGICAL LIMITED** [GB/GB]; Crane House, Molly Millars Lane, Wokingham, Berkshire RG41 2RZ (GB). **THE UNIVERSITY OF LEEDS** [GB/GB]; Leeds LS2 9JT (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **RUSSELL, Stephen, John** [GB/GB]; 14 Cromwell Road, Harrogate, N Yorks HG2 8DH (GB). **HAMPSHAW, Eric** [GB/GB]; 8 Ash Grove, Stanley, Wakefield WF3 4JY (GB). **RATHOD, Manoj, Kantilal, Chhaganlal** [GB/GB]; 15 Rowan Close, Birstall, Batley, W Yorks WF17 0ED (GB).

(74) Agent: **JONES, Stephen, Anthony**; Adamson Jones, 32a Stoney Street, Nottingham NG1 1LL (GB).

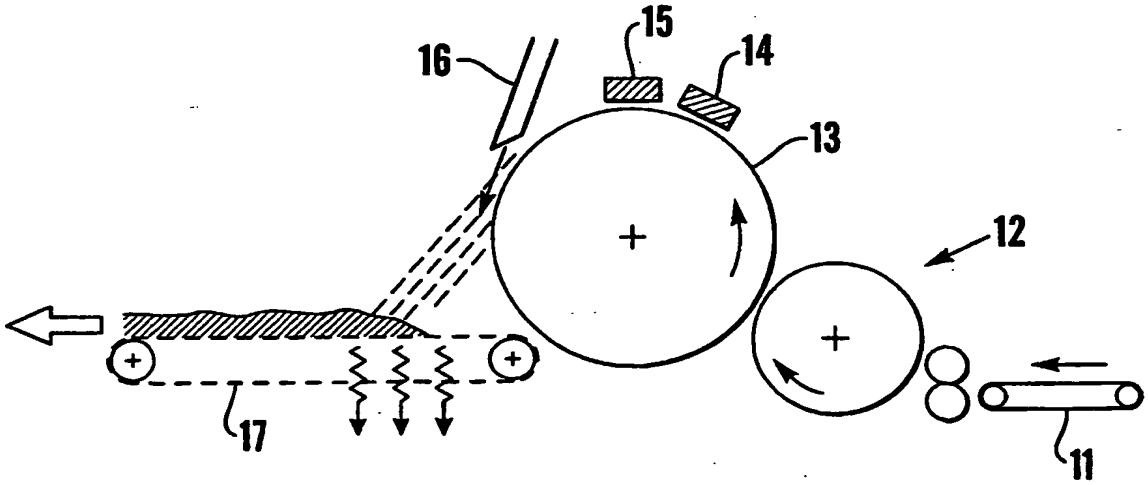
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FILTRATION MEDIA AND THE MANUFACTURE THEREOF



(57) Abstract: A process for the manufacture of a filtration medium comprises air-laying fibres to form a non-woven web. The process may be a roller-based air-laying process, in which raw fibres are transferred to a rapidly rotating cylinder or roller clothed with teeth, or a sifting-based air-laying process in which the fibres are circulated over a mesh screen. In either case, the fibres are dispersed in a moving air stream and deposited to form the non-woven web. Filtration media produced in accordance with the invention are electrostatically charged and are characterized by a high degree of isotropicity.

WO 01/21283 A1

FILTRATION MEDIA AND THE MANUFACTURE THEREOF

This invention relates to the manufacture of filtration media and in particular to the manufacture of electrostatic filtration media suitable *inter alia* for respiratory filtration applications, and to novel filtration media produced thereby.

Filtration media are widely used in many applications, for example for the capture of airborne particles (bacteria, dust etc). In such filters it is desirable for the resistance to airflow to be low, without sacrificing the filtration efficiency (ie the effectiveness with which the filter captures the airborne particles). A known measure intended to achieve these objectives is the creation of electrostatic charge on the filter material. Such a charge serves to attract the airborne material. One particular field of application of such electrostatically-charged filter media is respiratory filtration.

US 4,798,850 describes the formation of filter material with a felt structure composed of a blend of clean polypropylene fibres and clean fibres of an addition polymer comprising one or more halogen-substituted hydrocarbons. The felt is made by carding fibres into a web and needling them to form a coherent fabric structure.

In the carding operation, fibres are worked by a series of toothed rollers, which serve to disentangle the fibre and provide some mixing to increase the homogeneity of the blend. The product from the carding machine is a continuous web, which is peeled from the last main roller on the machine (doffer). The orientation of fibres in the web leaving the doffer is substantially dictated by the orientation of fibres leaving the doffer and is predominantly in the machine direction. In carding, the assembly of the web takes place mainly on the doffer and fibres are controlled by fibre to metal friction in the machine. The web is subsequently layered to produce a so-called batt structure that is then mechanically bonded.

In general, it is desirable to be able to produce filtration media having satisfactory filtration efficiencies and low resistance to airflow, without having excessively high weight or thickness. It is also desirable to be able to achieve these objectives without having to resort to multi-layer structures in which the filtration medium is laminated with, or bonded to, other material.

There has now been devised an improved method of forming non-woven filter materials which offers significant advantages over the prior art.

According to the invention, there is provided a process for the manufacture of a filtration medium, which process comprises air-laying fibres to form a non-woven web.

The process according to the invention is advantageous over the prior art in several respects, including the following:

(i) The fibre orientation in the web is more random (owing to the dispersion of loose fibres in air immediately before web formation). Web properties are consequently more isotropic.

(ii) No carding step is required (as compared to the prior art) and consequently the resulting structure does not consist of individual layers of web assembled one on top of the other. A single integrated structure is produced.

(iii) The air-laid web structure can be characterised by pronounced orientation in the z-direction (or perpendicular to the web surface). This gives the structure higher bulk (for a given area density) than a carded web.

(iv) Using the sifting air-lay approach, fibres of 2-12mm can be converted into uniform web structures (in contrast to the prior art, which permits only lengths of typically 30-200mm to be processed (due to restrictions imposed by carding).

(v) A shorter web formation process is achieved as compared to carding.

(vi) Providing it is clean, short, waste fibres (eg polypropylene) can be used in the process assuming the length is at least 2mm. Such short fibres are incompatible with the carding process.

In the air-laying process, the manner of web formation is substantially different from the prior art and marked differences in fabric properties are obtained. In air-laying, fibres are transferred to either

(a) a rapidly rotating cylinder or roller clothed with teeth and interacting with either other toothed rollers or fixed carding plates or

(b) a sifting screen or rotor device in which fibres are circulated over a mesh screen and then passed through an air-stream to form a web structure.

The former approach (roller-based air-laying) is presently preferred. In both processes, the mechanical working treatment is much shorter than that used in carding but is sufficient to electrostatically charge the fibre. In contrast to carding, the effect can be created solely at the site of interaction between the feed rollers and the opening roller. No further working points (eg worker rollers) are required. Electrostatic charging of the fibres is believed to be achieved as the fibres are separated between a set of feed rollers and a single rapidly rotating roller, or as they are contacted by the rotors and mesh yarns of the grid. Multiple rollers as used in carding are not required. In further contrast to carding, the charged fibr s are then dispersed freely in a moving air stream to form an air/fibre mixture. Th air then transports fibres from the rotating cylinder (or sifting area) to a suctioned mesh conveyor belt, screen or drum where the fibres are landed to form the web. The belt/drum acts as an air/fibre separator. The process is continuous and web weight depends on the speed of the landing drum or conveyor.

After web formation, consolidation of the web structure may be achieved using needle-punching.

The weight of the filtration media produced in accordance with the invention may be varied from approximately 200g/m^2 up to 1000g/m^2. For respiratory filter applications basis weights in the range 350-500g/m^2 would normally be selected.

To improve or modify performance characteristics (eg flow resistance, filtration efficiency, dimensional stability and fluid transmission) ready-made fabrics, scrims or films can be attached to fabrics produced in accordance with the invention.

As mentioned above, the properties of the web formed in the process according to the invention are more isotropic than in the prior art. This may manifest itself in a lower ratio of the tensile strengths of the web in the machine and cross directions (MD:CD), ie the longitudinal and transverse directions of the web as it is manufactured. Thus, according to a second aspect of the invention there is provided a filtration medium comprising a non-woven web of fibrous material, said web having an MD:CD ratio of less than 2:1. More preferably, the MD:CD ratio is less than 1.5:1.

Preferably, a blend of two or more types of fibre is used in the process of the invention. Most preferably, the blend comprises (a) a polyolefin and (b) an addition polymer comprising one or more halogen-substituted hydrocarbons. The former component of the blend is preferably polypropylene and the latter may be, for instance, polyvinylchloride or polyvinylidene chloride.

The blend may contain other fibres, either alternatively or in addition to those mentioned above. Examples of other fibre types which may be included are polyethylene and "modacrylic", ie a copolymer comprising from 35 to 85 weight percent acrylonitrile units and preferably having the balance made up substantially of other addition polymer-forming units, being halogenated hydrocarbon such as vinyl chloride or vinylidene chloride.

The components of the blend may be present in any suitable proportions. Preferably, the weight ratio of (a):(b) is in the range 70:30 to 30:70. Most preferably, the two classes of fibre are present in approximately equal proportions ie in each case between 45% and 55% by weight.

Preferably, the linear density of the two classes of the fibres in the blend is similar and is in the range 0.1 - 10 dtex (dtex = weight in grams of 10,000m of fibre).

Most preferably, the fibres are of less than 3.3 dtex. In terms of fibre diameter, the diameter is most preferably 12μm or less.

The fibres are preferably substantially free from any fibre finishes, oils or other extraneous matter prior to blending. Such chemicals are ideally removed from the fibres by an aqueous scouring process using a solution containing a synthetic detergent, sodium carbonate or a potassium carbonate solution. Other scouring regimes may also be suitable. The scouring process should be followed by thorough rinsing and drying stages prior to further processing.

Likewise, all mechanical processing machinery must be thoroughly cleaned, preferably by chemical means, to remove all fibre finish, waxes, grease, anti-static agents or other chemical residues.

Currently preferred embodiments of the invention will now be described in greater detail, by way of illustration only, with reference to the accompanying drawings, in which

Figure 1 is a schematic diagram of a roller-based air-laying process; and

Figure 2 is a schematic diagram of a sifting-based air-laying process.

Roller-Based Air-Laying

Roller-based systems can take many forms. A basic embodiment is illustrated in Figure 1. In a roller-based air-laying process raw fibres are transferred first from a feed conveyor 11 to a clothed feed roller system 12 and then to a rapidly rotating cylinder 13 which is clothed with teeth and interacts with fixed carding elements 14,15 or some other clothed surface (eg clothed rollers). Electrostatic charging of the fibres is achieved as the fibres are opened on the clothed cylinders 12,13. An air knife 16 displaces fibres from the cylinder 13 on to a perforated conveyor 17 to which suction is applied from below. A non-woven web of fibre is built up on the

perforated conveyor 17 from which the web is drawn off and consolidated by needle-punching.

Sifting-Based Air-Laying

An example of a sifting-based air-laying process is illustrated in Figure 2. In such a process, loose fibre is contained within a drum 21 having a grid 22 at its base. Rotors 23 within the drum 21 displace fibres in an air stream on to the top surface of a perforated conveyor 24, to which suction is applied from below. Again, the non-woven web is built up on the conveyor from which it is drawn off and consolidated by needle-punching. Airflow in the system is constrained between a pair of rollers 25,26, the downstream one of which 26 also applies compression to the web. Other systems that use rotating rollers or brushes instead of a static grid and rotors may also be used.

Fibre Blends

Examples of fibre blends which may be used are:

a) Polyvinylchloride / Polypropylene

b) Polyvinylchloride / Modacrylic / Polypropylene

c) Polyvinylchloride / Polypropylene / Polyethylene

d) Polyvinylchloride / Modacrylic / Polyethylene

In each case, the proportion of PVC in the blend is approximately 50%. All the fibres have diameters of 12µm or less and lengths in the range 2 to 12mm.

Experimental results have indicated that the method of the invention provides marked performance benefits in the filter media compared to the prior art:

(i) Up to a 20% reduction in the weight of the fabric can be achieved whilst maintaining a bacterial filtration efficiency of at least 99.9997%.

(ii) Up to a 39% reduction in the resistance to flow can be achieved (compared to the existing art) whilst maintaining a bacterial filtration efficiency of at l ast 99.9997%.

(iii) Bacterial filtration efficiencies of at least 99.99997% can be achieved with a single layer air-laid structure. No laminated or incorporated layers (eg meltblown fabrics) are required.

Typical results (resistance to flow and filtration efficiency) for fabrics produced using the method of the invention (specifically, the roller-based air-laying approach) are given in Table 1. These samples were a 50:50 blend of polyvinylchloride and polypropylene. Test results for fabrics produced by the prior art (50:50 modacrylic/polyvinylchloride) are given in Table 2 for comparison.

Table 1

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6B	491	2.1	99.999
4B	529	1.8	99.999
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Table 2

Test Results for Fabrics Produced by Prior Art Method

Sample ref	Fabric weight (g/m^2)	Resistance to flow @60 l/min (cmH_2O)	Bacterial Filtration Efficiency (%)
Prior art 1	511	2.3	99.9998
Prior art 2	496	2.2	99.99956

All tests were carried out on a pad of the respective fabric measuring 7.5x5.3cm and welded into a plastic housing with 22mm cylindrical inlet and outlet. Resistance to flow was measured in accordance with BS EN ISO 9360-1:2000. For bacterial efficiency, no standard currently exists. However, all products were tested in accordance with the former draft standard prEN 13328-1 Part 1.

Claims

1. A process for the manufacture of a filtration medium, which process comprises air-laying fibres to form a nonwoven web.

2. A process as claimed in Claim 1, comprising transfer of raw fibres to a rapidly rotating cylinder or roller clothed with teeth and interacting with other toothed rollers or fixed carding plates.

3. A process as claimed in Claim 1, comprising transfer of raw fibres to a sifting screen or rotor device in which fibres are circulated over a mesh screen.

4. A process as claimed in Claim 2 or Claim 3, wherein the fibres are subsequently dispersed in a moving air stream to form an air/fibre mixture.

5. A process as claimed in any preceding claim, wherein the fibres compris a blend of fibres of two or more types of fibre.

6. A process as claimed in Claim 5, wherein the blend comprises comprises (a) a polyolefin and (b) an addition polymer comprising one or more halogen-substituted hydrocarbons.

7. A process as claimed in Claim 6, wherein component (a) is polypropyl ne and component (b) is polyvinylchloride and/or polyvinylidene chloride.

8. A process as claimed in Claim 6 or Claim 7, wherein the blend further comprises a modacrylic copolymer comprising from 35 to 85 weight percent acrylonitrile units and having the balance made up substantially of other addition polymer-forming units, being halogenated hydrocarbon such as vinyl chloride or vinylidene chloride.

9. A process as claimed in any one of Claims 6 to 8, wherein the weight ratio of component (a) to component (b) is in the range 70:30 to 30:70.

10. A process as claimed in Claim 9, wherein the weight ratio of component (a) to component (b) is in the range 45:55 to 55:45.

11. A process as claimed in any one of Claims 6 to 10, wherein the linear density of the fibres in component (a) and component (b) is in the range 0.1 to 10dtex.

12. A process as claimed in Claim 11, wherein the linear density of the fibres is less than 3.3 dtex.

13. A process as claimed in any preceding claim, wherein the fibres have a diameter of 12µm or less.

14. A filtration medium comprising a non-woven web of fibrous material, said web having a ratio of the tensile strengths of the web in the machine and cross directions (MD:CD), ie the longitudinal and transverse directions of the web, of less than 2:1.

15. A filtration medium as claimed in Claim 14, wherein the MD:CD ratio is less than 1.5:1.

16. A filtration medium as claimed in Claim 14 or Claim 15, wherein the web comprises a blend of fibres of two or more types of fibre.

17. A filtration medium as claimed in Claim 16, wherein the blend comprises (a) a polyolefin and (b) an addition polymer comprising one or more halogen-substituted hydrocarbons.

18. A filtration medium as claimed in Claim 17, wherein component (a) is polypropylene and component (b) is polyvinylchloride and/or polyvinylidene chloride.

19. A filtration medium as claimed in Claim 17 or Claim 18, wher in the blend further comprises a modacrylic copolymer comprising from 35 to 85 weight percent acrylonitrile units and having the balance made up substantially of other addition polymer-forming units, being halogenated hydrocarbon such as vinyl chloride or vinylidene chloride.

20. A filtration medium as claimed in any one of Claims 17 to 19, wherein the weight ratio of component (a) to component (b) is in the range 70:30 to 30:70.

21. A filtration medium as claimed in Claim 20, wherein the weight ratio of component (a) to component (b) is in the range 45:55 to 55:45.

22. A filtration medium as claimed in any one of Claims 17 to 21, wherein the linear density of the fibres in component (a) and component (b) is in the range 0.1 to 10dtex.

23. A filtration medium as claimed in Claim 22, wherein the linear density of the fibres is less than 3.3 dtex.

24. A filtration medium as claimed in any one of Claims 14 to 23, wherein the fibres have a diameter of 12µm or less.

25. A filtration medium as claimed in any one of Claims 14 to 24, which has a weight of from 200g/m² to 1000g/m².

26. A filtration medium as claimed in Claim 25, wherein the medium has a weight of 350-500g/m².

27. A filtration medium as claimed in any one of Claims 14 to 26 which comprises a blend of fibres selected from the group consisting of

a) Polyvinylchloride / Polypropylene;
b) Polyvinylchloride / Modacrylic / Polypropylene;
c) Polyvinylchloride / Polypropylene / Polyethylene; and

d) Polyvinylchloride / Modacrylic / Polyethylene.

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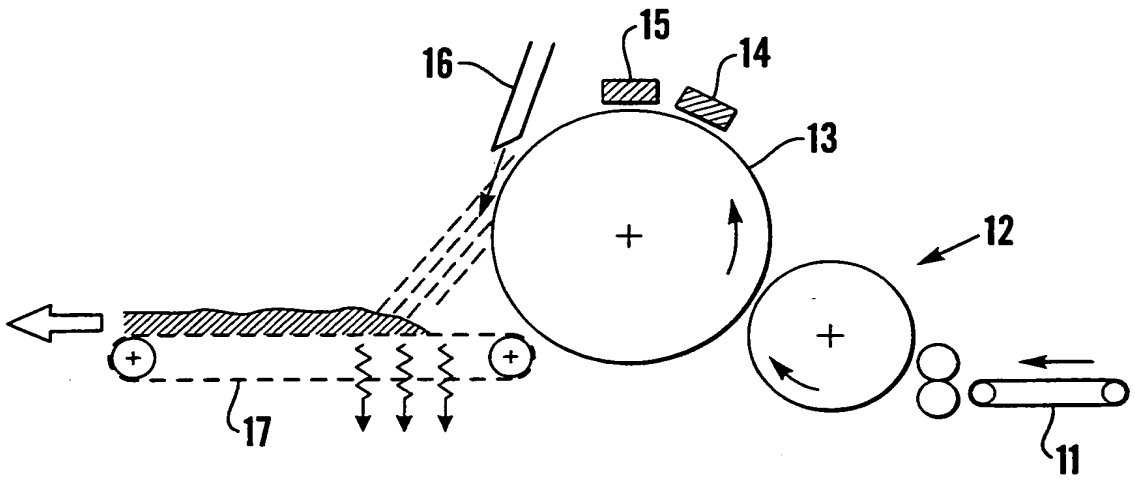

Fig. 1

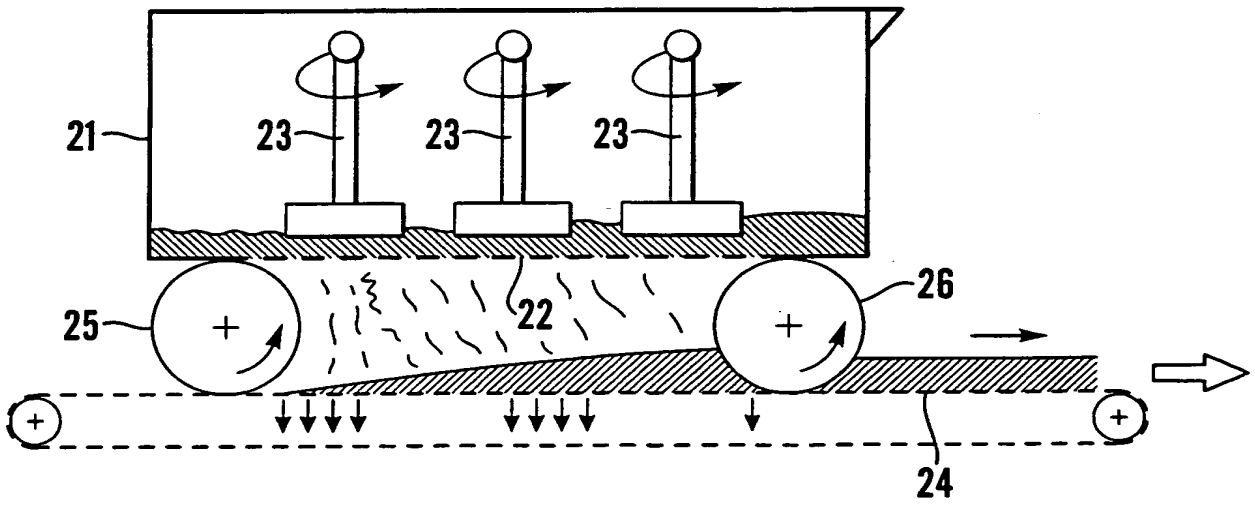

Fig. 2

INTERNATIONAL SEARCH REPORT

Interr ıal Application No
PCT/GB 00/03538

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D39/02 B01D39/04 D04H1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 230 800 A (NELSON DAVID L) 27 July 1993 (1993-07-27) column 1, line 39-41 column 3, line 36-64 column 3, line 19-34 column 4, line 3,4	1,6,7, 14,17,18
X	US 4 097 965 A (GOTCHEL JOEL PETER ET AL) 4 July 1978 (1978-07-04)	1-5
Y	Y-Doc. with EP0406485 or US3568846 abstract	6,7,17, 18
Y	Y-Doc. with US4374894	14-16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 December 2000	19/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hoffmann, A

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INTERNATIONAL SEARCH REPORT

Interr ıal Application No
PCT/GB 00/03538

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 778 494 A (SOWELL LYLES HOWARD ET AL) 14 July 1998 (1998-07-14) abstract	1-5
Y	Y-Doc. with US4374894	14-16
Y	Y-Doc. with EP0406485	6,7,17, 18
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Y	EP 0 406 485 A (NPBI BV) 9 January 1991 (1991-01-09) abstract; claim 9	6,7,17, 18
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INTERNATIONAL SEARCH REPORT

...ormation on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5595659 A		WO 9625219 A	22-08-1996

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c) Polyvinylchloride / Polypropylene / Polyethylene; and

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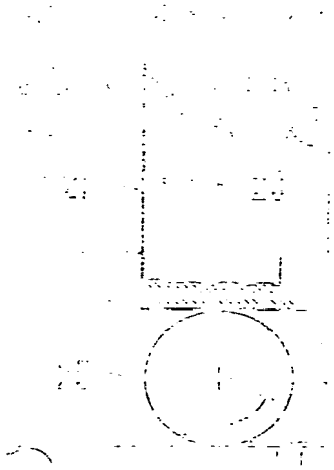

PATENT COOPERATION TREATY

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PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

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United States Patent and Trademark Office, PCT
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Date of mailing (day/month/year) 28 May 2001 (28.05.01)	
International application No. PCT/GB00/03538	**Applicant's or agent's file reference** 180/58/P/WO
International filing date (day/month/year) 14 September 2000 (14.09.00)	**Priority date** (day/month/year) 14 September 1999 (14.09.99)
Applicant RUSSELL, Stephen, John et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

11 April 2001 (11.04.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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